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# SERVICIO GEOLOGICO DE BOLIVIA

PROGRAMA DEL SATELITE TECNOLOGICO DE RECURSOS NATURALES

II

CALLE FEDERICO ZUAZO 1673  
ESQ. REYES ORTIZ

CASILLA DE CORREO 2729  
LA PAZ - BOLIVIA

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CR-146148

No. 29950, EARTH RESOURCE TECHNOLOGY SATELLITE (ERTS-A)  
SENSOR DATA FOR MINERAL RESOURCE SECTOR DEVELOPMENT AND  
USE SURVEY

RECEIVED  
NASA STI FACILITY  
ACQ. BR. *Not Specified*

FEB 18 1976

DCNE# 104200  
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JULY - OCTOBER

1975

(E76-10139) EARTH RESOURCE TECHNOLOGY  
SATELLITE (ERTS-A) SENSOR DATA FOR MINERAL  
RESOURCE SECTOR DEVELOPMENT AND USE SURVEY  
Progress Report, Jul. - Oct. 1975 (Servicio  
Geologico de Bolivia, La Paz.) 11 p HC \$3.50 G3/43

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Dr. Carlos E. Brockmann *etc.*  
Principal Investigator  
BOLIVIAN ERTS-PROGRAM

29950

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JAN 12 1976

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Servicio Geológico de Bolivia  
Casilla 2729  
La Paz - Bolivia

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## INTRODUCTION

The ERTS-Bolivia Program has been performing works of the mapping of Bolivian natural resources, after multidisciplinary studies with LANDSAT-1 imagery were made.

The multidisciplinary study of the Department of Potosí in Hydrology, Regional Geology, Structural Geology, Vulcanism, Geomorphology and Soil was made covering an approximate area of 118.200 Km<sup>2</sup> at an approximate scale of 1:250.000.

Similarly, another project was developed in the Department of La Paz, related to Hydrology, Geomorphology, Structural Geology, Mining Geology and Soel, adding Forestry and Current Land Use at a 1:250.000 scale covering an area of approximately of 110.000 Km<sup>2</sup> using the following images; 1191-14084 (10% cloudiness), 1191-14091 (40% cloudiness), 1191-14093 (40% cloudiness), 1065-14091 (0% cloudiness) 1100-14034 (40% cloudiness), 1190-14035 (50% cloudiness), and 1100-14041 (0% cloudiness). Although it is necessary to mention that even though all subjects were studied, a zone remained to be studied due to a lack of imagery.

Using part of this information, it was also possible to make a preliminary hydrological study of the Beni River Basin, resulting in the preparation of hydrological, geological, geomorphological, and soils maps of an area of 110.000 Km<sup>2</sup>. This work has had to be accomplished with the photoindexes of existing aerial photographs due to the excessive cloudiness on the LANDSAT images of the area. This study let us obtain for the first time some preliminary knowledge of the area as even partial data was not previously available.

The "La Paz Project" as well as the "Hydrological Project of the Beni River Basin" will be completed with LANDSAT-2 imagery, which so far have partially covered zones which previously had cloudiness problems.

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All of the works mentioned above are being processed in order to permit sending results to the National Aeronautics and Space Administration in as timely a manner as possible.

## 2.0 IMAGE FILES

Due to the fact that LANDSAT-1 imagery areas are well known and since it has been proved that LANDSAT-2 image areas do not change their original position, the corresponding geographical nomenclature was maintained (Fig. 1).

LANDSAT-2 imagery control is being made graphically on the Bolivia map at a 1:1.000.000 scale and coverage of 70% of Bolivia has been obtained with LANDSAT-2 imagery.

## 3.0 IMAGE PROCESSING

In order to keep originals sent by EDC, all 70 mm negatives and diapositives are duplicated in all of the bands that are used to make the necessary studies in the miniaddcol and CV-8 image analizer. In this way the original films are protected from possible damage during operational use.

This same element is also used to enlarge black and white images to 1:1.000.000 and 1:250.000 scales.

The 9.5 inch diapositives are used to prepare diazo color composites. It was settled that a combination of green in band 5 and red in band 7 provides excellent results. There also are other possible combinations such as using green in band 5 and sepia in band 7 for delimiting vegetation in arid zones. Combination of bands 4, 5 and 7 processed respectively in yellow magenta and cyan colors also are used.

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### 4.0 MULTIDISCIPLINARY PROGRAM

#### 4.1 Cartography

##### 4.1.1 Photomosaics.

The Military Geographic Institute is researching the possibility of preparing an area photomosaic with LANDSAT-1 images of San Borja, Trinidad, Covendo, and Chapare River (Fig. No. 1), using the existing control points in the zone determined by the Georeceiver system.

This research is being performed at a 1:1.000.000 scale in order to study the possibility of using bulk imagery for the preparation of a semi-controlled photomosaic of the whole country.

##### 4.1.2 Photomaps.

The possibility of processing maps using computer compatible tape (CCT's) at a 1:250,000 scale is being studied in order to analyze its precision in comparison with maps prepared by the Military Geographic Institute at the same scale. Radiometric and geometric corrections would be made in the CCT processing using existing control points of the area. The Desaguadero River image area of has been chosen as the first test site as it covers an entire existing 1°x 1°30' cartographic sheet format.

#### 4.2 Geology

##### 4.2.1 Regional Geology

4.2.1.1 Interpretation for preparing the geological Map of Bolivia at a 1:1.000.000 scale.

35% of the country is covered.

4.2.1.2 Interpretation and compilation of the Geologic Map of Bolivia via at a 1:250.000 scale.

25% of the country is covered.

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## 4.2.2 Tectonics

4.2.2.1 Structural interpretation of the Bolivian Altiplano. This work currently is being reviewed.

100% of the Altiplano area has been interpreted.

4.2.2.2 Linement interpretation of Bolivia. This work is being pursued using LANDSAT-2 imagery.  
28% of the country is covered.

## 4.2.3 Mineralization

4.2.3.1 Studies related to mineralization and lineament problems of the Cordillera Occidental section, the Altiplano, and part of the Cordillera Oriental of the Bolivian Andes at a 1:250.000 scale have been completed.

This work is currently reviewed.

100% of the study area has been

4.2.3.2 CCT use for iron minerals identification.

This work is being performed jointly with ERIM and System Planning Corporation with an AID grant.

4.2.3.3 CCT use for porphyritic copper minerals for prospection.

This work is being considered.

4.2.3.4 CCT use for copper minerals in the Totora formation (Desa guadero image).

This work is being performed jointly with LARS/PURDUE.

## 4.2.4 Geomorphology

4.2.4.1 Bolivia Geomorphology Map preparation at a 1:1.000.000 scale.

23% of the country is covered.

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4.2.4.2 Bolivia Geomorphology Map preparation at a 1:250.000 scale.  
25% of the country is covered.

4.2.4.3 Geomorphology legend preparation, to be used with the works  
mentioned above.

Completed.

## 4.2.5 Petroleum Exploration

4.2.5.1 Due to a lack of LANDSAT-1 imagery of the appropriate areas  
for oil accumulation this sub-program is being pushed with  
the arrival of LANDSAT-2 imagery.

## 4.2.6 Vulcanism

4.2.6.1 Vulcanism maps that have been prepared at 1:1.000.000  
and at 1:250.000 scales are being evaluated.

## 4.3 Agronomy

4.3.1 Physiognomic map at a 1:1.000.000 scale  
25% of the country is covered.

4.3.2 Physiognomic map at a 1:250.000 scale  
25% of the country is covered.

### 4.3.2.1 Soil Classification

Researches using CCT's are being made according to an  
Agreement signed between IDRC of Canada and the Bolivia  
ERTS Program. CCT analysis will be done in LARS/PURDUE

### 4.3.3 Actual Land Use.

#### 4.3.3.1 Legend

The Actual Land Use legend prepared in March and presented  
at the Earth Resources Symposium in Houston, was  
reviewed and corrected, mainly in the Rangelands, Forest  
Lands and Cultivated Lands categories.

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The work previously done was based on aerial observations made of the Desaguadero River, Lake Titicaca, Apolo, Heath River, Cobija, Madre de Dios, Riberalta, Guayaramerín, Roga guado, Trinidad, Ascención and Santa Cruz image areas. Field studies of the Cabezas, Camiri, Vallegrande, Sucre and Oruro image areas were made using both LANDSAT-1 and LANDSAT-2 imagery.

#### 4.3.3.2 Land Use Map.

Interpretation of 12 Landsat images, at a 1:250.000 scale. 18.75% of the country has been covered.

#### 4.3.4 Ecological Map

The ecological map of Bolivia prepared at a 1:1.000.000 scale has been published.

The report on the use of LANDSAT imagery in developing this map remains to be completed.

#### 4.4 General Mapping of Forests

##### 4.4.1 Legend

A map legend adapted to humid forests, tropical forests and sub-tropical forests has been composed, based on LANDSAT imagery interpretation factors and the completion of several experimental studies.

##### 4.4.2 Forest types and physiognomic vegetation classification.

Under this sub-program, the preliminary interpretation of 10 LANDSAT-1 images was done, and will be completed using LANDSAT-2 imagery.

The previously mentioned work was verified with aerial examination in order to confirm the delineation and the appropriateness of the interpretation key.

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## 4.5 Hydrology

Under this sub-program Bolivia drainage maps at a 1:250.000 scale are being prepared.

30% of the country is covered.

## 5.0 SPECIAL PROJECTS

### 5.1 Patacamaya-Tambo Quemado Road

The Desaguadero Rives image, enlarged to a scale of 1:250.000, is being studied for the purpose of selecting a route for this road.

### 5.2 Remote Sensing Project in Demography and Current Land Use

Sponsored by USAID (United States Aid for International Development), researches regarding this application are being made. Actual Land Use interpretation works are being done.

Further, base maps are being prepared from LANDSAT images, showing drainage features and selected cultural features, for operational use in the population census to be carried out in September 1976, in the extensive zones in which reliable cartography information does not exist.

### 5.3 Data Collection Platforms (D.C.P.)

An agreement with the U.S. Geological Survey was signed in November 1974 for the purpose of studying the possibility of receiving signals transmitted from Bolivia, approximately 3.800 miles away at the receiving station at NASA's Goddard Space Flight Center.

The U.S. Geological Survey has sent a DCP ID 6331 to Bolivia. It was installed at 16°30'S lat, 68°13'W long, at an altitude of 3950 meters. Transmission began January 31, 1975. The signals were not received at the Goddard Space Flight Center, probably due to a defective A-3 printed circuit in the DCP.

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In order to continue the experience, the US Geological Survey sent DCP ID.6312 this, platform was installed at 17°15' S lat and 67°54' W lon, at an altitude of 3.600 meters. Good transmission fo the equipment was verified before installation. However, the transmitted signals were not received by airher NASA Goddard Space Flight Center or by the NASA tracking station in Colina, Santiago de Chile.

Even though results so far are negative, it is still believed that the research should continue after NASA instolls appropiate equipment to be provided to the Colina Station in Chile.

Further research is needed to determine whether or not such equipment should be purchased; it has provided good results in the USA and such results would be extremely valuable to Bolivia.

## 6.0 PROBLEMS

Due to the recent arrival of the CV-8 image analizar and because of the lack of experience in its use, it has not yet been possible to develop systematic research programs that make use of it.

## 7.0 DATA QUALITY AND SCLUTION

### 7.1 EDC images are of excellent quality and of very good resolution

It must be stated that the products sent by EDC were found to be better in quality and resolution than the ones sent by NDPP, although there is still some noise produced in teh Scanner causing defects in the images obtained. It must also be said that some images do not have a sufficient number of coordenates, a problem that must be solved as soon as possible.

### 7.2 Timelinees of Data Delivery

LANDSAT-2 imagery arrival in Bolivia takes an average time of 12 weeks which is considered reasonable.

### 7.3 Test Site Coverage

Even though the coverage of all the country of Bolivia was specified within the Provisions of Participation for the ERTS Follow-on Program,

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it has been changed by excluding zones which do not have LANDSAT imagery coverage due to excessive cloudiness, as the rainy season will start soon in this part of the south hemisphere. This change must be altered as soon possible.

### 8.0 CONCLUSIONS

LANDSAT-1 and 2 imagery is used in the performance of the ERTS Bolivia Program for preparing a Bolivian natural resources inventory, which is being used by differente institutions as a basis for complementing more detailed studies of areas pre-selected based on the imagery interpretation information.

### 9.0 RECOMMENDATIONS

To obtain as soon as possible the total coverage of Bolivia within the time period mentioned in participation agreement, with a cloudiness of not more than 30%, in order to plan the Bolivian applications activities for 1976.

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MAPA DE LA REPÚBLICA  
DE

## BOLIVIA

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